LASER PULSE IMAGE SWITCHES

Background - Field of Invention:

[0001] This invention relates to switches and to the use of ~~submillimeter~~ information symbols or scenes on MicroElectroMechanical System (MEMS) mirrors and/or on the exit mirrors of laser ~~diode~~ arrays and the like. Definition: " image " defined as the pattern or form or relative position of photons in an optical pulse, beam or front as it moves through space, optical fibers and the like. These " images " become visible when the photons encounter a surface or are displayed, this is, also, commonly called an image.

Background - Prior Art:

[0002] The use of binary switches and the resulting binary code have required that relatively long code strings be used to represent or transmit simple symbols. The output or product of " LASER PULSE IMAGE SWITCHES " could be a stream (string) of very short (femtosecond) laser pulses, small enough (~~submillimeter~~ diameter or cross section) to be

carried on optical fiber systems. Each laser pulse being a discrete, separate, ~~submillimeter~~ image of information symbols or scenes and the like.

[0003] The following four patents: Sakuma et al., U.S. Patent #6,292,305 B1; Betensky et al., U.S. Patent#5,745,301; Tanaka et al., U.S. Patent#5,754,712; and Braat, U.S. Patent#6,317,276 B1; disclose operations on images, respectively: display; demagnification; searching, storing and displaying; writing and/or reading. They do not create the image signal or image input. The creation of the image signal or image input as ~~submillimeter~~ images would be the purview of " LASER PULSE IMAGE SWITCHES ".

[0004] Sakuma et al., U.S. Patent # 6,292,305 B1 disclose a virtual screen display apparatus and ... a relatively small image display for displaying characters or image information... [apparently of a size to be human observable] or

"Means to create minuscule alphanumeric images by reflection and by/in the light pulse, for presentation on a real or virtual display screen" (from 2002, April 2 O.A.). As shown in Fig. 15,(Sheet 15 of 20, lower left) and described in Column 1, Lines 5-10 this device displays images which are created by an output device. The creation of these images would be the purview of " LASER PULSE IMAGE SWITCHES ", an output device.

[0005] Lens systems to produce small images of varying magnification for detection by an electronic imaging system or "Lens systems for producing small images" (from 2002, April 2 O.A.) are disclosed by Betensky et al. (U.S. Patent 5,745,301).

[0006] An image processing apparatus for searching, storing, and displaying characters, sentence fragments, sentences or documents or "A device for searching any character string of a sentence input as an image" (from 2002, April 2 O.A.) is disclosed by Tanaka et al. (U.S. Patent 5,754,712).

[0007] An optical lens system and scanning device for reading and/or writing information in an information plane or "An optical scanning device for reading and writing information in an information plane" (from 2002, April 2 O.A.) is disclosed by Braat (U.S. Patent 6,317,276 B1).

[0008] The absolute/unique distinction between, the four patents referenced above (Sakuma et al., Betensky et al, Tanaka et al., and Braat) and "LASER PULSE IMAGE SWITCHES", can be demonstrated by reference to Sakuma et al., U.S. Patent 6,292,305 B1, Sheet 15 of 20, FIG. 15. In the lower left corner of FIG. 15 is the term "IMAGE SIGNAL", to the left of that would be the purview of "LASER PULSE IMAGE SWITCHES".

[0009] The same distinction would apply to the other three patents: Tanaka et al., U.S. Patent 5,754,712, Sheet 1 of 23, FIG. 1, upper left, "IMAGE INPUT UNIT", above that would be the purview of "LASER PULSE IMAGE SWITCHES".

Betensky et al., U.S. Patent 5,745,301, ABSTRACT, First sentence, "Variable power lens systems for use with electronic imaging systems, e.g. systems employing CCDs, are provided." , would be synergistic with the purview of "LASER PULSE IMAGE SWITCHES".

Braat, U.S. Patent 6,317,276 B1, ABSTRACT, Last sentence, "This lens system is very suitable for a scanning device and an apparatus for reading/writing high-density optical discs." , would be synergistic with the purview of "LASER PULSE IMAGE SWITCHES".

[0010] "LASER PULSE IMAGE SWITCHES" would likely be synergistic with OCR equipment.

[0011] The prior four patents refer to operations performed on images which could be created, or produced by " LASER PULSE IMAGE SWITCHES ".

[0012] "An electrically actuated microelectromechanical television scanning device for television image scanning or related functions. The scanning device can be produced in forms having characteristic dimensions in the submillimeter range. ..." is disclosed by Johnson (U.S. Patent 5,673,139). This patent does not show or infer any attempt or concept to create, form or etch, ~~submillimeter~~ information symbols or scenes onto the switch elements, i.e. optical surfaces (mirrors, laser ~~diode~~ exit mirrors, ~~liquid crystal elements,~~ or the like). Hence, Johnson, U.S. Patent 5,673,139, does not anticipate "LASER PULSE IMAGE SWITCHES".

[0013] A "... light-actuated photonic switch is disclosed..." by Aksyuk et al., U.S. Patent 6,075,239. This patent does not describe any attempt or concept of creating, forming or etching ~~submillimeter~~ information symbols or scenes onto the switch elements, i. e. optical surfaces (reflectors, mirrors, or the like). Hence, Aksyuk et al., U.S. Patent 6,075,239, does not anticipate " LASER PULSE IMAGE SWITCHES ".

[0014] " A cross-connect switch for fiber-optic communication networks employing a wavelength dispersive element, such as a grating, and a stack of regular (non-wavelength selective) cross bar switches using two-dimensional arrays of micromachined, electrically actuated, individually-tiltable, controlled deflection micro-mirrors for providing multiport switching capability for a plurality of wavelengths. ..." is disclosed by Solgaard et al., U.S. Patent 6,389,190 B2. The word " image " is used in several places in Column 2, it is clear ,from the context, that the meaning is to position or focus the optical beams onto mirrors or fiber ends. This patent does not describe any attempt or concept of creating, forming, or etching ~~submillimeter~~ information symbols or scenes on the switch elements, i.e. optical surfaces (micro-mirrors, gratings, or the like). Hence, Solgaard et al., U.S. Patent 6,389,190 B2, does not anticipate " LASER PULSE IMAGE SWITCHES ".

[0015] The above ~~These~~ patents: Johnson, U.S. Patent 5,673,139 , Aksyuk et al., U.S. Patent 6,075,239, and Solgaard et al., U.S. Patent 6,389,190 B2, are likely to be synergistic with " LASER PULSE IMAGE SWITCHES ".

[0016] Sullivan et al, U.S. Patent # 6,466,185 B2, "Multi-Planer Volumetric Display System and Method of Operation Using Psychological Vision Cues" discloses "... An image projector selectively projects images on respective optical elements to generate a volumetric three-dimensional image viewable in the multi-surface optical device. Psychological vision cues are added..." (Abstract).

Note: The above is clearly a human scale display device.

Sullivan continues "... In a further embodiment, different technologies may be used to implement the SLM (spatial light modulations) provided that high speed operation is attained. For example high speed liquid crystal devices, modulations based on

micro-electromechanical (MEMS) devices, or other light modulating method may be used to provide such high frame rate imaging. For example, the Digital Light Processing (DLP) technology of TEXAS INSTRUMENTS, located in Dallas Tex.; the Grating Light Valve (GLV) technology of SILICON LIGHT MACHINES, located in Sunnyvale, Calif.; and the analog ferroelectric LCD devices of BOULDER NONLINEAR SYSTEMS, located in Boulder, Colo., may be used to modulate the images for output by the image projector 20. Also, the SLM may be a ferroelectric liquid crystal (FLC) device, and polarization biasing of the FLC SLM may be implemented.

To obtain very high resolution images in the MVD (Multi-Planer Volumetric Display) system 10, the images 44-50 must be appropriately and rapidly re-focused onto each corresponding optical element of the MOE (multiple optical element) device 32, in order to display each corresponding image on the optical element at the at the appropriate depth. ..."(Col. 12, Lines 49-68+).

[0017] This patent does not describe any attempt or concept of etching information symbols or scenes onto MEMS mirrors, laser arrays, or

gratings. Sullivan et al., U.S. Patent # 6,466,185 B2, does not anticipate " LASER PULSE IMAGE SWITCHES ".

[0018] Also, Sullivan, Fig. 1, lower center, shows "Graphic Input Source", to the right of that would be the purview of "LASER PULSE IMAGE SWITCHES ", an output device.

[0019] "Optical Switching Device, Picture Display and Projection Apparatus", U.S. Patent # 6,198,566 B1 to Takeda et al., discloses ... ..." a light guiding member equipped with a total reflection surface capable of transmitting an incoming light ray for image display by means of total reflection, and an optical switching member having a micro prism that extracts evanescent light leaking out of the total reflection surface and reflects it to a display area of the total reflection surface. "(Abstract).

Takeda et al., discloses an "ON/OFF" optical switch, Fig. 2 & 3 and Col. 2, line 29 et al..

[0020] This patent does not describe any attempt or concept of etching, information symbols or scenes into the switch elements, i.e. optical surfaces (micro-mirrors, gratings, micro-prisms, or the like). Hence, Takeda et al., U.S. Patent 6,198,566 B1, does not anticipate

" LASER PULSE IMAGE SWITCHES ".

[0021] Barrett et al., U.S. Patent # 6,005,990, "System For Optically Scanning Images Using Optical Shutter", discloses .... "...a light source 102 , a optical shutter 104, an optical sensor 106, and a scanner controller 108. The light source102 and optical shutter 104 cooperatively "present" an image to the optical sensor 106. ... and creates an electronic representation of the scanned image." (Col. 2, lines 52 – 65).

[0022] Barrett continues, "... the scanning cursor is the smallest possible unit of scanning resolution with a monolithic or segmented monolithic optical sensor. And, the entire image area is scanned by sequentially moving the scanning cursor in a pattern to systematically traverse the entire image area. For each sequential position of the scanning cursor, the optical sensor 106 measures the shuttered light corresponding to that region of the image area. For each of the many tiny regions of the image areas, then, the optical sensor 106 thus creates an electrical output signal representative of the light signal detected at that region. ..." (Col. 12, lines 2 –15).

[0023] The Applicant respectfully asserts that the Barrett reference (Col. 1, lines 30-31, Figs. 1,8,10 11,12) discloses "... optical image scanning by presenting the image to an optical sensor via an optical shutter. ..." and that optical shutter scanning by a scanning device with transparent qualities does not anticipate; discrete, separate, laser light pulse images with a predetermined duration (femtosecond) and a predetermined size and the like.

[0024] This patent does not describe any attempt or concept of etching information symbols or scenes on the switch elements, i.e. optical surfaces (micro-mirrors, gratings, laser exit mirrors, or the like). Hence, Barrett et al., U.S. Patent 6,005,990, does not anticipate " LASER PULSE IMAGE SWITCHES ".

[0025] "Arrangement for Shifting Optical Images Between Individual Channels" to Buttner, U.S. Patent # 5,936,759, discloses "... A plurality of imaging optical systems adapted to image conjugately upon each other, in an associated shiftable optical channel, an associated plane and an intermediate image

plane, comprise a micro-mechanical mirror system (mirror array) arranged in ... such a manner, that they optically connect optionally one of the shiftable channels to the common channel."(Abstract).

[0026] This patent does not describe any attempt or concept of, etching information symbols or scenes into the switch elements, i.e. optical surfaces (micro-mirrors, gratings, laser exit mirrors, or the like). Buttner, U.S. Patent # 5,936,759, does not anticipate " LASER PULSE IMAGE SWITCHES ".

[0027] The above four patents: Sullivan et al., U.S. Patent #6,466,185 B2; Takeda et al., U.S. Patent#6,198,566, B1; Barrett et al., U.S. Patent#6,005,990; and Buttner, U.S. Patent#5,936,759; disclose operations on images, respectively: volumetric display, switching-display-projection, optically scanning, and shifting optical images.

[0028] They do not infer, imply, or describe the etching of information symbols or scenes into the optical surfaces of MEMS mirrors, laser exit mirrors and the like.

[0029] The above four patents: Sullivan et al., U.S. Patent #6,466,185 B2; Takeda et al., U.S. Patent#6,198,566, B1; Barrett et al., U.S. Patent#6,005,990; and Buttner, U.S. Patent#5,936,759; are likely to be synergistic with " LASER PULSE IMAGE SWITCHES ".

[0030] The unique, enabling paradigm of " LASER PULSE IMAGE SWITCHES " is the ~~creation, formation, or etching~~, etching, creation, or formation of ~~submillimeter~~ information symbols or scenes onto the optical surface(s) of MEMS mirrors, exit mirrors of laser ~~diode~~ arrays~~, submillimeter liquid crystal displays,~~ and the like; and the creation of ~~submillimeter~~ optical images of these ~~submillimeter~~ information symbols or scenes with very short pulses, ~~of submillimeter dimension (diameter, etc.),~~ of laser light; and the selective switching of these laser pulses to create a string of ~~submillimeter~~ images. The prior patents do not infer, suggest, or describe this paradigm.

Objects and Advantages:

[0031] ~~Submillimeter~~ Information, including scenes and/or alphanumeric symbols, on the mirrors of MEMS switches, and/or the exit mirrors of laser ~~diode~~ arrays and the like, allow the representation, switching and/or transmission of information ~~submillimeter~~ images with very short pulses of laser light.

[0032] One embodiment, an array of 256 ~~submillimeter~~ image switch elements (MEMS mirrors, laser ~~diode~~ arrays and the like) with ~~submillimeter~~ alphanumeric symbols on each switch element could function as an ~~submillimeter~~ alphanumeric image string switch.

[0033] The use of a, sequence label, in the switch address system would allow switching to any/all of the 256 image switch elements in any sequence, with each address operation. By including a, sequence plus time index label, the potential ~~submillimeter~~ alphanumeric image string can become extremely long for each address operation.

[0034] The advantage of laser pulse image switches would be the increased efficiency of directly switching, transmitting, manipulating, and storing information as ~~submillimeter~~ images of alphanumeric symbols or scenes, without the archaic conversion into binary code and the subsequent decoding.

Summary:

[0035] ~~Submillimeter~~ Information symbols or scenes formed on MEMS mirrors and/or the exit mirrors of laser ~~diode~~ arrays and the like, allow these devices to function as laser pulse information image switches, producing a string of laser light pulses, each an image of ~~a submillimeter~~ information symbols or scenes. These switches would be used in optronic/photonic devices and systems/networks.

Description:

[0036] ~~Submillimeter~~ Information symbols or scenes, (reflective or nonreflective, positive or negative), are etched or formed onto the mirrors of MEMS switches and/or the exit mirrors of laser ~~diode~~ arrays and the like (other optical switch devices ~~including liquid crystal devices~~). By selectively switching which MEMS mirror reflects a laser light pulse ~~(submillimeter)~~ or which laser ~~diode~~ emits a laser light pulse ~~(submillimeter),~~ these devices function as laser pulse image switches.

Operation:

[0037] A light pulse ~~(submillimeter)~~ , reflected or emitted from a laser pulse image switch element would form a ~~submillimeter~~ image of the symbol(s)/scene(s) on that element. These pulses could be ultra-short (femtosecond) and each pulse, a discrete, separate, and different image. The light pulse image(s) could be directed into an optical fiber for transmission. Projection of the light pulse image(s) onto a CCD chip (or screen) would provide readout. Storage might be recording of the symbol image(s) directly onto a CD (or with light stopping methods of Rowland Institute).

Conclusion, Ramifications and Scope:

[0038] The limiting factor may be the number of photons necessary to form an image. Many paths toward that limit appear possible: for example, extremely small symbols, extremely short light pulses, multiple symbols on each switch element, lens systems, very high element number switches; i.e. current MEMS switches have 256 mirrors (possible symbols), frequency multiplexing; i.e. each frequency of the light pulse forming an image, and reflective symbols on a nonreflective background. Alternatively: symbols might be formed directly onto the exit mirrors of ~~submillimeter~~ lasers such that the laser pulse, itself, is the image; or ~~submillimeter~~ images created by passing the light pulse through a ~~submillimeter, liquid crystal~~ image medium.

Eventually, a ~~submillimeter~~ image may be worth a thousand bits.

Remarks:
General:

The Applicant has amended the title, specification, claims, and abstract of Patent Application Number 09/784,773 to conform with the Office Action mailed April 2, 2002, and with the Office Action mailed August 7, 2002 and with the Office Action mailed September 20, 2002 and with the Office Action mailed September 2, 2003 and with the Office Action mailed December 5, 2003.

The elements presented in this Amendment E are a clarification and expansion of intent and concepts presented in the original application and references (original and O.A.) and do not, in the view of the Applicant, constitute "new" technical material.

The term "LASER PULSE IMAGE SWITCHES" is descriptive and not intended to be restrictive. A "laser pulse alphanumeric image switch" would also be a "laser pulse image switch". Static, laser pulse image switches would have unchanging symbols or scenes on the switching elements. Dynamic, laser pulse image switches would have the ability to change the symbols or scenes on the switching elements, ~~e.g. liquid crystal switching elements and the like~~.

Current optronic/photonic system laser technology employs lasers with a wavelength of approximately 1.5 microns (10-6 meters). This would be the lower limit of laser pulse image switch resolution using current technology, i.e. information symbols or scenes on laser pulse image switch elements would be about 1.5 microns or larger in size ~~(up to about 0.5 millimeters)~~.

In a manner of speaking, motion picture projectors, still-slide projectors, TVs, displays (real/virtual), and the like, are image switching devices. These images can range from very large (I-Max) to very small (microdot). These projectors/screens can range from centimeters to meters in size.

In the Applicant's opinion, laser pulse image switching devices based on MEMS switches and laser ~~diode~~ arrays and the like (and the technology involved) are unique and novel devices~~, these are submillimeter switch elements and images, and centimeter sized devices~~. These ~~submillimeter~~ images would be machine operable and would likely need to be enlarged several times to be human observable.

A switch is commonly defined to have two possible states, either on or off. Laser pulse image switches expand the envelope of switch definitions. The laser pulse image switch embodiment described in "Objects and Advantages", with 256 switch elements would have 256 possible single states, or, if combinations are allowed, the possible number of states becomes very, very large. Such a device might be named an "optitch", for optical image switch.

References:

The red, blue and green color switching disclosed by Sakuma et al., U.S. Patent 6,292,305 B1, column 21, lines 3 - 64 et al., to create the illusion of a color image, does not appear to anticipate "LASER PULSE IMAGE SWITCHES".

Tanaka et al., U.S. Patent 5,754,712 column 8, lines 37, 50 - 67 et al., apparently describes binary, on/off, switches and does not appear to anticipate "LASER PULSE IMAGE SWITCHES".

"The scanning device ... having characteristic dimensions on the submillimeter range." disclosed by Johnson, U.S. Patent 5,673,139, Fig. 1, Fig. 2 and Fig. 20 -25 does not show any attempt or concept to create, form, or etch ~~submillimeter~~ information symbols or scenes onto the optical surfaces i.e. switch elements; and does not appear to anticipate "LASER PULSE IMAGE SWITCHES".

"LASER PULSE IMAGE SWITCHES" and the referenced articles and patents appear to describe all of the elements necessary to develop prototype information systems/networks of laser pulse image optronic/photonic devices.

The potential increase of information transfer rates by laser pulse image switches in optronic/photonic devices and/or systems/networks over binary code systems/networks would seem to make laser pulse image switch based optronic/photonic devices and/or systems/networks useful.

The US Patent 5,673,139 to Johnson does not describe, or show any concept of etching information symbols or scenes on/in the optical surface(s) of the device. The Johnson patent does not contain the terms: "laser pulse image(s)" or "image switches" or "laser pulse image switches". The Johnson patent does not contain the terms: ~~"liquid crystal display" or~~ "optronic-photonic devices, systems or networks".

The Applicant respectfully requests reassessment of last line on page 3 plus the first two lines on page 4 of the Office Action dated September 20, 2002. " ... the Johnson reference ... explicitly discloses a submillimeter image switching device in the abstract, lines 3-4, Figs 19a and 19b." The Applicant respectfully asserts that the Johnson reference (abstract, lines 3-4, Figs. 19a and 19b) discloses " The scanning device ... having characteristic dimensions in the submillimeter range." and that raster scanning by a scanning device with submillimeter dimensions does not anticipate;

discrete, separate, laser light pulse images with a predetermined duration (femtosecond) and a predetermined size ~~(submillimeter)~~ and the like.

Also, Figs. 19a, 19b and Figs. 20-25 do not anticipate or show any concept of creating or etching information symbols or scenes onto or into the optical surfaces of the Johnson device.

Response to Office Action of December 5, 2003.

Note: No drawings were filed with this application (09/784,773).

In the Applicant's opinion, Item 10 of the Office Action (OA) Summary, page 1, is not relevant.

The OA continues:

Page 2, items 1-2, "Claims 5-9 are rejected under 35 U.S.C. 112 ... Deletion of the new matter is required." Claims 5-9 have been canceled. New Claims 33-52 have been written to comply with this rejection. The required matter plus has been deleted. The Applicant respectfully requests reconsideration and withdrawal of this rejection.

Page 3, items 3-4, "Claims 5-9 are rejected ... as being anticipated by Sullivan et al., U.S.P. No, 6,466,185.".

Claims 5-9 have been canceled. New Claims 33-52 have been written to comply with this rejection. The present invention has been more closely defined. The Applicant respectfully requests reconsideration and withdrawal of this rejection.

The referenced patents; Sullivan et al., U.S. Patent# 6,466,185 B2; Takeda et al., U.S. Patent#6,198,566, B1; Barrett et al., U.S. Patent#6,005,990; and Buttner, U.S. Patent#5,936,759; are discussed in the Background section, pages 9-15.

Additional comments to the Sullivan et al. Patent # 6,466,185 B2; Note in Fig. 1, et al., many devices, 9-10, are involved in the Sullivan et al. "...System...".

In embodiments, of the present invention, with symbols in/on MEMS mirrors, the number of devices is two; a MEMS laser pulse image switch and a laser source. In embodiments, of the present invention, with symbol images integral with emitted laser pulses, the number of devices is one; a laser pulse image switch. Support for "symbols on exit mirrors of lasers" is in the last two lines of page 2 of original application, February 15, 2001.

The single photon detector (IDS), could likely demonstrate single (one) photon images, for example; a period. .

The Applicant understands that "metamaterials" (IDS) have a negative index of refraction, and could become enhancement/enabling materials when synergistic with the present invention.

COMMENTS:

Another perspective; most of the devices of the referenced patents apparently require an image-input signal in the form of binary code, "LASER PULSE IMAGE SWITCHES" could create an output image signal of strings of very short laser pulses, small enough to be carried on optical fibers. Each laser pulse being a discrete, separate, image of information symbols or scenes. The referenced ~~patents/~~devices could likely be converted or adapted to handle the laser pulse image string as input, thereby becoming synergistic with this invention.

This invention presents information symbols or scenes in the form of laser pulse images, with predetermined durations, and with predetermined dimensions. There are likely many ways to create and manipulate these laser pulse images of information symbols or scenes. Hybrid devices, using binary code and laser pulse images synergistically, will likely have a place in the evolution of this paradigm.

This invention describes information symbols or scenes in the form of short duration laser pulse images ~~with submillimeter dimensions~~. This is a unique paradigm compared to the traditional methods of information symbols or scenes in the form of binary code.

end